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Charles Darwin University

Final Examination

Family Name						
Given Name/s						
Student Number						
Teaching Period	Semester 2, 2017					

ENG212 – Mechanics of Solids	DURATION	
	Reading Time:	10 minutes
	Writing Time:	180 minutes

INSTRUCTIONS TO CANDIDATES

1. Read **ALL** questions carefully.
2. Show all your working. Note that marks will be given for correct processes as well as correct results.
3. Marks are as indicated, the total is 100.
4. This paper contains six questions. Answer all **six (6)** questions.

EXAM CONDITIONS

<u>You may begin writing from the commencement of the examination session.</u> The reading time indicated above is provided as a guide only.

This is a CLOSED BOOK examination

Any non-programmable calculator is permitted

No handwritten notes are permitted

No dictionaries are permitted

ADDITIONAL AUTHORISED MATERIALS	EXAMINATION MATERIALS TO BE SUPPLIED
No additional printed material is permitted	1 x 20 Page Book 1 x Scrap Paper Formula Sheet/s

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Answered ALL questions in the Answer Booklet provided.

Marks for each question are indicated.

Question 1 (14 marks)

The 60° strain Figure 1 rosette is mounted on the surface of an aluminium plate. The following readings are obtained from each gauge: $\varepsilon_a = 950\times10^{-6}$, $\varepsilon_b = 380\times10^{-6}$, $\varepsilon_c = -220\times10^{-6}$. Determine the maximum in plane principal strains and their orientation. **(14 marks)**

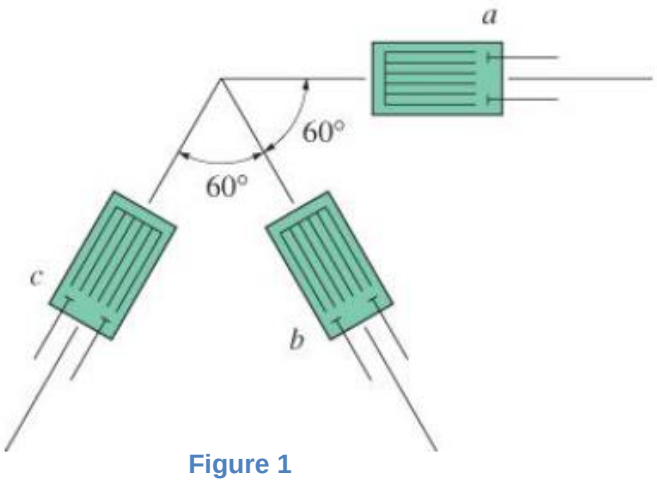

Figure 1

Question 2 (15 marks)

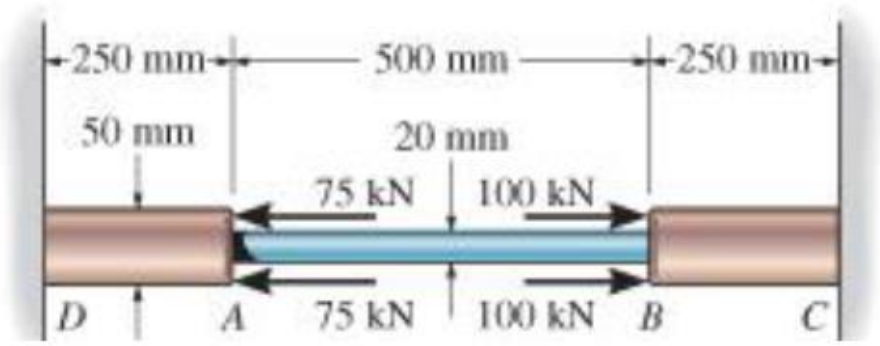

Figure 2

The composite bar shown in Figure 2 consists of a 20 mm diameter steel rod *AB* and 50 mm diameter brass end segments *DA* and *BC*. Two loads of 75 kN and another two loads of 100 kN are applied as shown in Figure 2. The bar is fixed to the wall at both ends.

Determine the displacement of A with respect to B due to the applied load. **(15 marks)**

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Question 3 (18 marks)

The beam shown in Figure 3a is subjected to a load. A cross section of the beam is shown in Figure 3b. For the beam shown below:

- Draw the shear and moment diagrams. **(6 marks)**
- Where does the maximum bending stress occur? **(1 mark)**
- Where does the maximum shear stress occur? **(1 mark)**
- Find the maximum shear stress in the beam at 1.5 m from the left side of the beam. **(5 marks)**
- Find the shear flow in the joint at point *A* (see Figure 3b) at 1.5 m from the left side of the beam. **(5 marks)**

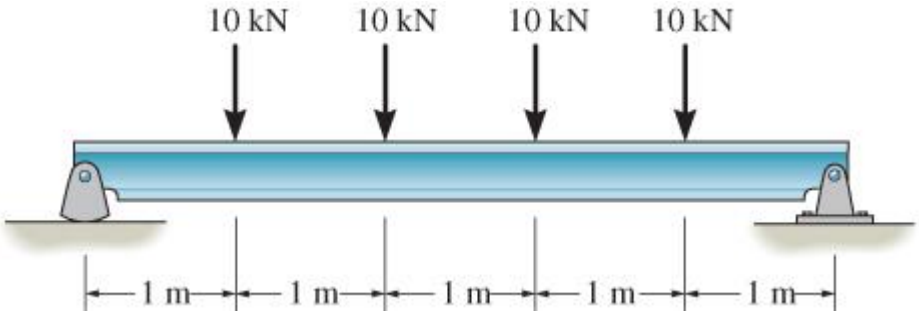

Figure 3a

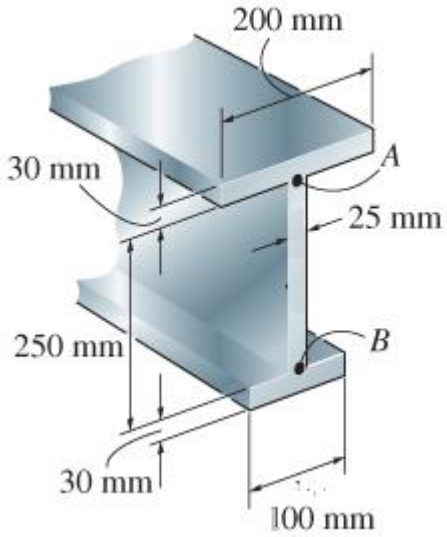

Figure 3b

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Question 4 (15 marks)

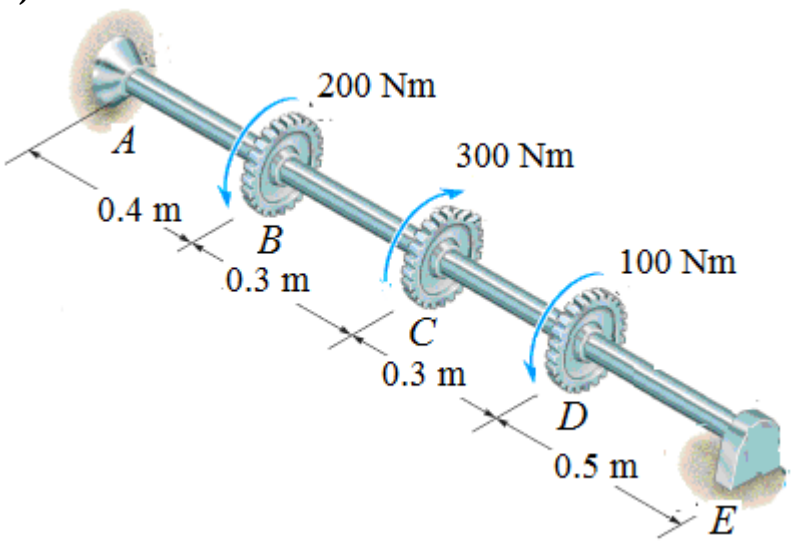

Figure 4

The stainless steel shaft shown in Figure 4 is solid with a diameter of 15 mm. The shaft is fixed at *A* and *E* (*A* and *E* do not rotate). The shear modulus of elasticity, *G* = 75 GPa.

For the torques shown, determine

a. the values of the maximum and the minimum shear stress in the shaft and the locations where these occur. **(8 marks)**
b. the angle of rotation between *B* and *C*.**(7 marks)**

Question 5 (19 marks)

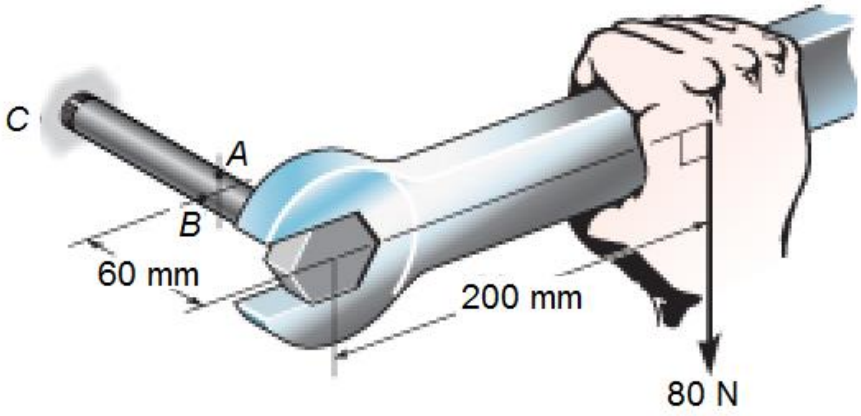

Figure 5

The bolt is in Figure 5 fixed to its support at *C*. A force of 80 N is applied to the bolt as shown. The length of the bolt is 14 cm and the diameter is 6 mm. It is made of bronze.

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Determine the values of

a. the axial (normal) force, shear force(s), torque and bending moment(s) at point *A* **(4 marks)**
b. the stresses caused by the normal force, torque, shear force(s) and bending moment(s) at point *A.* **(6 marks)**
c. the principal stresses at point *A.* **(6 marks)**
d. the absolute maximum shear stress at point *A.* **(3 marks)**

Question 6 (19 marks)

An aluminium beam is used to support the load w= 12 kN/m as shown in Figure 4. The solid beam is rectangular with a height of 200 mm and a width of 120 mm. The length of the beam L = 6 m. The modulus of elasticity for the beam is E = 70 GPa.

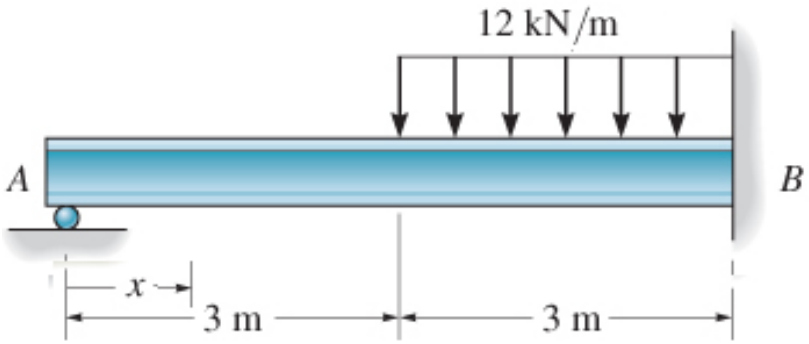

Figure 6

a. Express the bending moment along the length of the beam as a function of x in terms of the reaction force at *A.* **(3 marks)**
b. What is the deflection of the beam at *B?* **(1 mark)**
c. What is the slope of the beam at *B?* **(1 mark)**
d. Draw an exaggerated deflected shape for the beam. **(2 marks)**
e. Determine the value of the slope of the beam at *A* **(3 marks)**
f. Determine the reaction force at *A* **(3 marks)**
g. Determine the slope and the deflection of the beam halfway between *A* and *B* **(3 marks)**
h. Is this the maximum deflection of the beam? Explain your answer **(3 marks)**

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